

## ELECTRONIC APPARATUSES AND METHODS FOR PROVIDING A MAN-MACHINE INTERFACE (MMI)

### CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation-in-part application of U.S. application Ser. No. 14/156,010, filed on Jan. 15, 2014, which is a continuation application of U.S. application Ser. No. 13/007,791 (now U.S. Pat. No. 8,670,023, issued on Mar. 11, 2014), filed on Jan. 17, 2011, the entirety of which is incorporated by reference herein.

### BACKGROUND OF THE INVENTION

#### Field of the Invention

[0002] The invention generally relates to a Man-Machine Interface (MMI), and more particularly, to electronic apparatuses and methods for providing an MMI in which user operations in real space are corresponding to operations in virtual space.

#### Description of the Related Art

[0003] To an increasing extent, display screens are being used for electronic apparatuses, such as panel PCs, mobile phones, multimedia players, portable gaming consoles, etc. A Man-Machine Interface (MMI) may be a graphical interface displayed on a display screen and a user may interact with an electronic apparatus via certain hardware input units coupled thereto or therein, such as a touch pad, keyboard, mouse, etc. Alternatively, a display screen may be incorporated with touch sensors for detecting contacts of objects on the display screen, so that users may interact with the electronic apparatus by using pointers, styluses, fingers, etc., to manipulate the MMI on the display screen.

[0004] However, most MMIs employed with either hardware input units or touch sensors are provided as two-dimensional (2D) operation interfaces. Since more and more applications are requiring 3D user operations, it is therefore desirable to have an MMI which is capable of providing flexible 3D user operations with efficient calibrations.

### BRIEF SUMMARY OF THE INVENTION

[0005] In one aspect of the invention, an electronic apparatus comprising at least two camera devices and a processing device is provided. The processing device determines a first distance to a surface formed by the two camera devices and a second distance to the surface in response to detecting an object positioned at a first time by the two camera devices, and determines a third distance from the object positioned at a second time to the surface, wherein the second time is later than the first time, and the third distance is longer than the first distance and shorter than the second distance. Also, the processing device determines a depth in a virtual space corresponding to the object positioned at the second time according to the first distance, the second distance, and the third distance.

[0006] In another aspect of the invention, a method for use in an electronic apparatus comprising at least two camera devices is provided. The method comprises the steps of: determining a first distance to a surface formed by the two camera devices and a second distance to the surface in response to detecting an object positioned at a first time by

the two camera devices; determining a third distance from the object positioned at a second time to the surface, wherein the second time is later than the first time, and the third distance is longer than the first distance and shorter than the second distance; and determining a depth in a virtual space corresponding to the object positioned at the second time according to the first distance, the second distance, and the third distance.

[0007] Other aspects and features of the present invention will become apparent to those with ordinarily skill in the art upon review of the following descriptions of specific embodiments of the electronic apparatuses and methods for providing an MMI.

### BRIEF DESCRIPTION OF DRAWINGS

[0008] The invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

[0009] FIG. 1 shows a block diagram of an electronic apparatus according to an embodiment of the invention;

[0010] FIG. 2 is a schematic diagram illustrating an elevation view of the electronic apparatus 10 according to an embodiment of the invention;

[0011] FIG. 3 is a top view illustrating the determination of the proper range of user operations in depth of the real space according to an embodiment of the invention;

[0012] FIG. 4 is a top view illustrating the determination of the proper range of user operations in depth of the real space according to another embodiment of the invention;

[0013] FIG. 5 is a top view illustrating the determination of the proper range of user operations in depth of the real space according to still another embodiment of the invention;

[0014] FIG. 6 is an exemplary diagram illustrating the difference between the positions of an object in the images captured by the camera devices 12 and 13;

[0015] FIG. 7 shows an exemplary diagram of a triangle established in the stereo depth calculation according to an embodiment of the invention;

[0016] FIGS. 8A and 8B show an exemplary diagram illustrating the manipulation of an email box displayed on the display screen 11 according to an embodiment of the invention;

[0017] FIG. 9 is a diagram illustrating the mapping of the depth information of the user's gesture in the real space to the third dimensional information of the virtual space according to the embodiment of FIGS. 8A and 8B;

[0018] FIG. 10 is an exemplary diagram illustrating the manipulation of an interactive 3D modeling console displayed on the display screen 11 according to an embodiment of the invention;

[0019] FIG. 11 is a top view illustrating the mapping of the real space to the virtual space;

[0020] FIG. 12 is a diagram illustrating piece-wise linear relation between the user's gesture in the real space and the part of the virtual 3D model in the virtual space according to the embodiment of FIG. 11; and

[0021] FIG. 13 is a flow chart illustrating the method for providing an MMI according to an embodiment of the invention.